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Remarks:

Reconsideration of the application is respectfully requested.

Claims 9 - 10 are presently pending in the application. As it is believed that the claims were patentable over the cited art in their original form, the claims have not been amended to overcome the references.

On page 2 of the Office Action dated November 16, 2006, it was alleged that Applicants had not filed a certified copy of the German application, as required by 35 U.S.C. § 119(b). In response to that Office Action, Applicants stated:

On page 2 of the Office Action, it was stated that a certified copy of the foreign priority document was not yet available. In the event that Applicants find that the certified copy of the priority document was not previously filed, Applicants will file one prior to issue.

However, Applicants note that a certified copy of the priority document was filed in connection with U. S Patent Application Serial No. 09/761,241, now United States Patent No. 6,441,408. Both the '408 patent and the instant application claim priority from German Patent Application DE 198 32 310.7, filed in Germany on July 17, 1998. As such, since the Patent Office is already in possession of a certified copy of the priority document for the present case, Applicants believe that the

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requirements of 35 U.S.C. § 119(b) have been met, and that no further certified copy of the priority document need be filed.

In item 1 of the Office Action, claims 9 and 10 were rejected under 35 U.S.C. § 103(a) as allegedly being obvious over U. S. Patent No. 5,610,415 to Schulze ("SCHULZE") in view of Rosling et al., "A Study of Design Influence on Anode-Shorted GTO Thyristor Turn-On and Turn-Off", IEEE Transactions on Power Electronics, Vol. 9, No. 5, September 1994, pages 514 - 521 ("ROSLING").

Applicants respectfully traverse the above rejections.

More particularly, claim 9 recites, among other limitations:

an emitter region; and

a stop zone in front of said emitter region, the stop zone and said emitter region having mutually opposite conductivities, **the stop zone including sulfur atoms with at least one energy level within the band gap of the semiconductor and at least 200 meV away from both a conduction band and a valence band of the semiconductor**, the stop zone having a doping profile of sulfur atoms such that **the stop zone is only partially electrically active in the on-state and fully electrically active in the off-state for carriers emitted by the emitter region.** [emphasis added by Applicants]

claim 10 recites, among other limitations:

an emitter region; and

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a stop zone in front of said emitter region, the stop zone and said emitter region having mutually opposite conductivities, **the stop zone including selenium atoms with at least one energy level within the band gap of the semiconductor and at least 200 meV away from both a conduction band and a valence band of the semiconductor**, the stop zone having a doping profile of selenium atoms such that **the stop zone is only partially electrically active in the on-state and fully electrically active in the off-state for carriers emitted by the emitter region.** [emphasis added by Applicants]

However, neither the **SCHULZE** reference, nor the **ROSLING** reference, teach or suggest, **alone or in combination**, a power semiconductor element including an emitter region and a stop zone in front of the emitter region, the stop zone including **sulfur** (claim 9) or **selenium** (claim 10) atoms **with at least one energy level within the band gap of the semiconductor and at least 200 meV away from both a conduction band and a valence band of the semiconductor**, the stop zone having a doping profile of **sulfur** (claim 9) or **selenium** (claim 10) atoms such that **the stop zone is only partially electrically active in the on-state and fully electrically active in the off-state for carriers emitted by the emitter region.**

In rejecting Applicants' claims 9 and 10, page 4 of the Office Action stated, in part:

Furthermore, although neither Schulze nor Rossling necessarily teach the specific selection of either sulfur or selenium for said atoms Applicant is reminded that it has been held that mere selection of known materials generally understood to be suitable to

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make a device, the selection of the particular material being on the basis of suitability for the intended use, would be entirely obvious. In re Leshin 125 USPQ 416. *Combination of the teaching by Rosling et al with the invention by Schulze immediately satisfies said limitation* because gold (as acceptor (A): 290 meV), barium (as donor (D): 320 meV), cesium (as donor (D): 300 meV), molybdenum (300 meV), nickel (as acceptor (A) 350 meV) have at least one energy level within the band gap of silicon and 200 meV away from both the conduction band and valence band of silicon, as witnessed by the collected and evaluated data in Sze as made of record 5/15/02, page 21, Figure 13. (emphasis in original)

Additionally, in responding to Applicants' previous arguments, page 6 of the Office Action stated, in part:

Applicants' insistence on either sulfur or selenium is not consistent with patentability requirements long practiced by the USPTO; **see MPEP 2144.07**. [emphasis added by Applicants]

Applicants are well aware of MPEP 2144.07 and *In re Leshin*.

More particularly, MPEP § 2144.07 addresses the obviousness of the selection of a known material based on its suitability for its intended purpose, **when that suitability is recognized in the art**. MPEP 2144.07 is entitled "Art Recognized Suitability for an Intended Purpose" and cites to, among other cases, *Sinclair & Carroll Co. v. Interchemical Corp.*, 325 U.S. 327, 65 USPQ 297 (1945). MPEP § 2144.07 discusses the holding in *Sinclair & Carroll Co. v. Interchemical Corp.*, stating:

Claims to a printing ink comprising a solvent having the vapor pressure characteristics of butyl carbitol so that the ink would not dry at room temperature but

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would dry quickly upon heating were held invalid over a reference teaching a printing ink made with a different solvent that was nonvolatile at room temperature but highly volatile when heated **in view of an article which taught the desired boiling point and vapor pressure characteristics of a solvent for printing inks** and a catalog teaching the boiling point and vapor pressure characteristics of butyl carbitol. **"Reading a list and selecting a known compound** to meet known requirements is no more ingenious than selecting the last piece to put in the last opening in a jig-saw puzzle." 325 U.S. at 335, 65 USPQ at 301. [emphasis added by Applicants]

As can be seen by the foregoing, there was clearly an "art recognized suitability" in *Sinclair & Carroll Co. v.*

Interchemical Corp., because the cited art **explicitly taught the claimed characteristics** (i.e., "an article which taught . . .", "Reading a list and selecting a known compound . . .").

Similarly, *In re Leshin*, is mentioned in MPEP 2144.07

affirming the obviousness of the selection of a known plastic to make a container of a type made of plastics prior to the invention. Although there is no mention in MPEP 2144.07 of art recognizing the particular plastics as suitable for use in manufacturing lipstick containers, it seems likely that it was **generally recognized** that the chosen plastics would be suitable for such a use.

Neither MPEP 2144.07, nor *In re Leshin* appropriately applies to the present claims, since there is **no recognition generally**, or in the cited art, that **selenium** or **sulfur** would be suitable for use in a device as claimed by Applicants. Nor

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has any evidence been provided in the Office Action that would show that the suitability of using selenium or sulfur in such a device would have been generally recognized at the time of invention. Indeed, as will be discussed below, neither selenium nor sulfur would have been suitable for use in the device of the **SCHULZE** reference, cited in the Office Action.

More particularly, page 4 of the Office Action cites to various non-sulfur, non-selenium materials that allegedly "have at least one energy level within the band gap of silicon and 200 meV away from both the conduction band and valence band of silicon". Page 4 of the Office Action then jumps to the conclusion that, since selenium and sulfur also have this characteristic, they would be suitable for the intend use, and their selection would, therefore be obvious. Applicants respectfully disagree with this conclusion.

The prior art **fails to teach or suggest**, among other limitations of Applicants' claims, **that sulfur or selenium have the particularly claimed characteristics** (i.e., at least one energy level within the band gap of silicon and 200 meV away from both the conduction band and valence band of silicon). Nor is there any allegation in the Office Action that these selection criteria of sulfur and selenium would have been "generally known" at the time of invention. Because

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these characteristics of sulfur and selenium were neither taught by the art, nor generally known, it would not have been obvious to a person of ordinary skill in the art, at the time of Applicants' invention, to use sulfur or selenium in a device as claimed by Applicants', from a reading of the **SHULZE** and **ROSLING** references. That sulfur and selenium atoms have at least one energy level within the band gap of silicon 200 meV away from both the conduction band and valence band of silicon was not recognized in the art or generally known, prior to Applicants' claimed invention. As such, the suitability of using sulfur or selenium in a device of the type claimed by Applicants, would also not have been recognized in the art or generally known, prior to Applicants' claimed invention. Rather, the understanding of the suitability criteria of the claimed materials has been impermissibly derived from **Applicants' own disclosure and claims**.

Therefore, the present case is not one of "Art Recognized Suitability for an Intended Purpose", to which MPEP 2144.07 can be applied. Among other reasons, there has not been any showing of prior art or general knowledge at the time the invention was made, of a recognition of the suitability of sulfur or selenium for the purpose intended in the claims, or

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that recognizes the criteria used by Applicants to determine such suitability.

That there are materials shown in the prior art that also happen to meet the suitability criteria disclosed by the Applicants, is not an indication that the desirability of such criteria were generally known in the art, or that use of other materials - such as selenium or sulfur - would meet that (hitherto unknown to be desirable) criteria. Nor do the materials shown in the prior art make these criteria for suitability obvious - other criteria could have been (and were) applied in the prior art to select suitable materials.

For example, as will be discussed below, **SCHULZE** discloses that the selection criteria for "suitability" were that the materials "act as dopants of the first conductivity type above the operating temperature ... whereas they are electrically active to only a relatively slight extent at the normal operating temperature." See, for example, col. 2 of **SCHULZE**, lines 7 - 19. While the materials listed in the Office Action -- gold, barium, cesium, molybdenum, and nickel are all listed as meeting this standard of suitability in **SCHULZE**, sulfur and selenium (as will be discussed further below) **would not**.

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The rejection of claims 9 and 10 over a combination of **SCHULZE** and **ROSLING**, seems to rely on the teachings of **SCHULZE** and **ROSLING** being modified to use sulfur or selenium (i.e., since neither **SCHULZE**, nor **ROSLING**, suggest the use of sulfur or selenium), as the "additional substance" added to the second emitter 4 and the portion 9 of the inner region 1 of the device shown in **SCHULZE**. Since it appears that **ROSLING** is relied upon only to show the use of silicon as the semiconductor in a GTO thyristor, arguendo, and does not otherwise add anything of particular relevance to the teachings of **SCHULZE**, the following discussion will focus on **SCHULZE**.

As argued by Applicants in the responses to the previous Office Actions, incorporated herein by reference, neither sulfur nor selenium would have been suitable for use in the device shown in **SCHULZE**. More particularly, **SCHULZE** (who is also an inventor in the present application) did not teach using sulfur and selenium in the **SCHULZE** because neither sulfur, nor selenium, would have been appropriate for use in the device of **SCHULZE**. In fact, use of either sulfur or selenium in the device of **SCHULZE** would change the principle of operation of the device shown in **SCHULZE**, and render it unsatisfactory for its intended purpose. Thus, the **SCHULZE** reference cannot be modified as suggested in the Office

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Action, because, the suggested modification to the device of **SCHULZE** would impermissibly destroy the teachings of **SCHULZE** (i.e., "change the principle of operation" and "render it unsatisfactory for its intended purpose"). See, for example, MPEP 2143.01 (V) and (VI).

Col. 2 of **SCHULZE**, lines 3-20, states:

In order to avoid these current lines or filaments, at least the second emitter 4 is then doped with additional substances in addition to the standard dopants of the second conductivity type such as, for example, boron. These dopants are selected such that they act as dopants of the first conductivity type above the operating temperature, i.e. at 300° C. and above, whereas they are electrically active to only a relatively slight extent at the normal operating temperature. For the standard case where the second emitter zone is p-doped, these additional substances must thus have donor properties at 300° C. Molybdenum, niobium, cesium or barium, for example, come into consideration as additional substances having such donor properties. In that case wherein the opposite zone sequence is present and the second emitter 4 is n-doped, the additional substances must have acceptor properties above the operating temperature. Cadmium, zinc, gold, or nickel, fix example, are substances suitable therefor.

As such, one of the goals of **SCHULZE** is to prevent damage to the device by causing a strong local reduction of the emitter efficiency at temperatures above the operating temperature. This is achieved in **SCHULZE**, by doping the second emitter 4 with substances that act as dopants of the first conductivity type above the operating temperature and are only slightly electrically active at normal operating temperatures. In

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SCHULZE, these "additional substances" may also be introduced beyond the second emitter into the adjoining region of the inner zone 1. **SCHULZE** gives examples of Molybdenum, niobium, cesium, and barium as suitable "additional substances", if the second emitter is p-doped (which would be the proper case under consideration, since for purposes of considering the present invention, selenium and sulfur, if used, are n-type dopants). Col. 2 of **SCHULZE**, lines 21 - 29, state:

What these substances have in common is that, dependent on the doping concentration of the first substances, they partially or entirely compensate the doping of the emitter zone 4 above the operating temperature, i.e. at about 300° C. and above. For a complete compensation of the first dopants present in the second emitter zone 4, the doping concentration of the additional substances should be as high as that of the first substances. [emphasis added by Applicants]

As such, **SCHULZE** discloses that the additional substances are intended to partially or entirely compensate the doping of the second emitter zone above the operating temperature.

First, as discussed above, **SCHULZE** discloses that these "additional substances" are selected "such that they act as dopants of the first conductivity type above the operating temperature, i.e. at 300° C and above, whereas they are electrically active to only a relatively slight extent at the normal operating temperature". See, for example, col. 2 of **SCHULZE**, lines 3 - 11. While it is correct that both selenium

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and sulfur will have temperature-dependent donor activity, it is also the case that selenium and sulfur are both electrically active to more than a "relatively slight extent" at a normal operating temperature of the device of SCHULZE. In particular, either selenium or sulfur would be at least 30% to 40% activated at room temperature. This makes selenium and sulfur unsuitable for use in the device of SCHULZE, and contradicts the express teachings of SCHULZE.

If selenium or sulfur were used in the device of SCHULZE, despite their activation at room temperature, they would reduce the ability of the device of SCHULZE to operate for its intended purpose, leaving the device either with substantially reduced efficiency at normal operating temperatures, or (if the doping concentrations of the "first substances" were increased to compensate for "additional substances" at normal operating temperature) with an inability to adequately reduce the efficiency of the device at high temperatures to prevent current filamentation in the case of overstress. These problems are not cured by the ROSLING reference, cited in the Office Action in combination with SCHULZE.

Further, as stated above, col. 2 of SCHULZE, lines 21 - 29, discuss that these "additional substances" are intended to partially or entirely compensate the doping of the second

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emitter zone above the operating temperature. In particular, SCHULZE stated that "the doping concentration of the additional substances should be as high as that of the first substances" (wherein the "first substances" in SCHULZE are understood to be the "standard" dopants, such as boron for a p-type dopant, as disclosed in col. 2 of SCHULZ, lines 5 - 7).

Both sulfur and selenium have a solid solubility in silicon that is orders of magnitude lower than the solid solubility of the "standard" dopants, such as boron in silicon. For example selenium and sulfur have a solid solubility in silicon in the range of 10^{16} to 10^{17} atoms/cm³, compared to the solid solubility of boron in silicon, which is on the order of 10^{20} atoms/cm³. Consequently, sulfur and selenium would not be suitable for achieving a doping concentration approximately as high as the doping concentration of a "standard" dopant in the second emitter zone, and would, therefore, be unsuitable for use in the device of the SCHULZE reference. Without the doping concentrations being **approximately the same**, the device of the SCHULZE reference may be unable to meet its goal of preventing damage to the device, since the local reduction of emitter efficiency at temperatures above the normal operating temperature would not be strong enough to prevent such damage. Thus, by using a substance such as sulfur or selenium, the SCHULZE reference may be rendered unsuitable for its intended

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purpose. The combination of the **SCHULZE** reference with the **ROSLING** reference, cited in the Office Action, also does not cure this deficiency of the **SCHULZE** reference.

In response to the above argument, page 7 of the Office Action stated, in part:

In response to Applicant's argument on limited solubility (page 10), said limited solubility of selenium and sulfur appears at best to be an incentive only to prefer boron for the background dopant in the stop zone, which is what Schulze does anyway, Keeping in mind that the recited foreign atoms are only needed to enhance beyond background level.

Pages 6 - 7 of the Office Action additionally states, in part:

Moreover, applicant appears to misconstrue Schulze in juxtaposing the selenium and sulfur dopants with boron: boron is not the selection of choice for the foreign atoms additionally introduced in stop zone 9, as opposed to their use as the background dopants for region 1 as a whole, including 9; but instead the recited foreign atoms satisfy the energy level limitations as claimed in the presence of the standard option of the semiconductor material on which the GTO thyristor is based (see Schulze col. 2, l. 3-20).

The above quoted statements from pages 6 - 7 of the Office Action appear to be inconsistent with the teachings of the **SCHULZE** reference. The **SCHULZE** reference teaches that the additional material (e.g., molybdenum, niobium, cesium, or barium) is added to the second emitter zone 4, and that its concentration there should be "as high as that of the first substance" (see, col. 2 of **SCHULZE**, lines 21 - 29). **SCHULZE** teaches that the "first substance" in the second emitter zone

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is a "standard" dopant of the "second conductivity type" (whereas the "additional substance" acts as a dopant of the "first conductivity type" at temperatures above the operating temperature). See, for example, col. 1 of **SCHULZE**, lines 48 - 49; col. 2 of **SCHULZE**, lines 4 - 16).

For example, if the second emitter zone of **SCHULZE** is p-doped (e.g., by using the "standard dopant" boron as the "first substance", as suggested at col. 2, lines 4-7), then the "additional substance" added to the second emitter zone of **SCHULZE** would need to act as an n-type dopant at temperatures above the operating temperature in order to cause a drastic reduction in the efficiency of the second emitter at temperatures above the operating temperature by compensating for the doping of the second emitter zone only at temperatures above the operating temperature. This compensation for the doping of the second emitter zone of **SCHULZE** is generally achieved if the "additional substance" in the second emitter zone of **SCHULZE** has a doping concentration **substantially similar to that of the "first substance" in the second emitter zone**. See col. 2 of **SCHULZE**, lines 25 - 29.

Assuming that, under the teachings of **SCHULZE**, the "first substance" in the second emitter zone is boron (p-type), then the "additional substance" would need to be a substance that

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acts as an n-type dopant at temperatures above the normal operating temperature (and that has little or no effect at normal operating temperature), and would need to be able to achieve a similar doping concentration to that of boron in the second emitter zone. Because of their low solid solubility in silicon, if silicon were used as the semiconductor (as suggested in the Office Action), and boron or some other "standard dopant" were used as the "first substance" in the second emitter zone (as suggested in **SCHULZE**), then neither sulfur, nor selenium, would be a suitable choice for the "additional substance", since they can only achieve a doping concentration that is orders of magnitude less than that of boron or other standard dopants. Therefore sulfur or selenium would not be able to compensate for the "standard dopant", such as boron, in the second emitter zone, as required by the teachings of **SCHULZE**.

Further, contrary to the statement made at the bottom of page 6 of the Office Action and the top of page 7, Applicants believe that it is entirely appropriate for Applicants to juxtapose the doping concentration of sulfur or selenium in the second emitter zone with that of boron, because this is what is taught in SCHULZE. See, for example, col. 2 of **SCHULZE**, lines 3 - 29. Applicants understand that the "stop zone" that the Office Action cites in **SCHULZE** is not the

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second emitter zone 4 of **SCHULZE**, but rather a portion 9 of the inner zone 1 that also may be doped with the same "additional substance" as the second emitter zone 4 of **SCHULZE**, as described at col. 2 of **SCHULZE**, lines 37 - 42. However, this does not mean that the teachings of **SCHULZE** relating to the "additional substance" and its use in the second emitter zone can be ignored. Rather, the **SCHULZE** reference **must be considered in its entirety**, as required by MPEP 2141.02 (VI). The fact that the "additional substance" of **SCHULZE** may be used in the "stop zone" 9, **as well as in its primary use in the second emitter zone 4 of SCHULZE**, does not permit use of an "additional substance", such as sulfur or selenium, **that would not be suitable for use in the second emitter zone of SCHULZE**. Doing this would impermissibly destroy the principles of operation of the **SCHULZE** reference.

Applicants further note that the suggestion on page 7 of the Office Action, about boron being a preferred background dopant in the stop zone of **SCHULZE**, appears to be technically incorrect. Boron, which is a p-type dopant, **is a preferred "standard dopant" for use in the second emitter zone of SCHULZE** - not the stop zone of **SCHULZE**. If, arguendo, as the Office Action suggests, sulfur or selenium - both n-type dopants - were used as the "additional material" in **SCHULZE** (which they would not be, for at least the reasons discussed

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above), then the preferred background dopant for the inner zone of **SCHULZE** (of which the "stop zone" 9 cited in the Office Action is a part) **would need to be an n-type dopant.**

For the foregoing reasons, among others, claims 9 and 10 are believed to be patentable over the **SCHULZE** reference. The **ROSLING** reference, cited in the Office Action in combination with **SCHULZE**, does not cure the above-discussed deficiencies of the **SCHULZE** reference. Accordingly, Applicants respectfully request that the rejections of claims 9 and 10 be withdrawn.

It is accordingly believed that none of the references, whether taken alone or in any combination, teach or suggest the features of claims 9 and 10. Claims 9 and 10 are, therefore, believed to be patentable over the art.

In view of the foregoing, reconsideration and allowance of claims 9 - 10 are solicited.

In the event the Examiner should still find any of the claims to be unpatentable, counsel would appreciate receiving a telephone call so that, if possible, patentable language can be worked out.